it for train service temporarily, until the new line, located at a higher elevation, is ready for use.

The Las Vegas Age quotes Vice-President J. Ross Clark as follows:

A special corps of engineers will take the field at once for the running of the new line, which will be pushed as rapidly as possible. Meantime the old road will be rebuilt. This will give us a safe line during the summer, and will give us a line to work from in our building project for the new line.

The cost of reconstructing the old line will not exceed $400,000, but what the new line will cost we do not know. There is a large part of the old line that can be used, and most of the big steel bridges in the canyon are in excellent shape.

Our supplies were ordered long ago, and a great part of them already are on hand here, and in Salt Lake. We will work on the old line from both ends at once, and will probably have it in shape within 90 days. After that the new line will be completed, and the old one will be taken up. In many places we will be able to use the old line all the time, so our cost on the new will not be excessive.

Mr. Bancroft agrees with me in the estimate of the cost; the reports sent out from Salt Lake that our loss is $12,000,000 are absolutely without foundation.

RELATION OF PRECIPITATION AND STREAM FLOW TO IRRIGATION PROJECTS.

By DANIEL W. MEAD, Consulting Engineer, Madison, Wis.

In order that any irrigation project be financially and agriculturally successful, an adequate supply of water must be absolutely assured for practically every irrigation season. A thorough consideration of this matter is, therefore, of primary importance.

The best information concerning the amount of water that can be obtained from any source is the actual and continuous measurement of the quantity of water from that source for a sufficient length of time to cover all varying climatic conditions which affect the flow of water from year to year, from season to season, and from day to day.

Unfortunately, in many cases these observations are not available for a long period of years, but observations covering a short period, while affording no criterion for judging the variations which will take place in the flow of a stream during a long term of years, are of value when comparing them with other and more extended records.

VARIATIONS IN STREAM FLOW.

The great variations that take place from year to year in the run-off of a stream is well shown by the measured annual discharge of the Provo River. The discharge of this stream has been measured almost continuously since 1889, or for about 20 years. For the year 1902 no flow records are available, and for some other years records of measurements are missing. In the following discussion of this stream the missing data have been supplied by adding to the actual measurement of flow, the mean discharges calculated from the actual flow for other years, for the missing months, so that the estimates as given are nearly complete and fairly accurate. Figure 1 gives the total annual discharge of the Provo River for each year from 1889 to 1908, inclusive, both in inches in depth and in acre feet per square mile from the drainage area. It will be noted that the annual discharge has varied from a minimum of 6.18 inches in 1905 to 14.42 inches in 1907. The maximum being 234 per cent. of the minimum.

It is evident, therefore, that it is necessary to observe stream flow for a considerable term of years in order to cover all probable variations, for in 20 years of observations on the Provo River, the flow of no other years has approached very closely to either the maximum flow of 1907 or the minimum flow of 1905.

EFFECT OF PRECIPITATION ON STREAM FLOW.

It is obvious that precipitation, including both rain and snow, is the primary cause of stream flow, and it would naturally be expected that an increase in rainfall will result in an increase in stream flow. While, as a rule, this is true, there are found to be radical exceptions to this rule. These exceptions are due to the fact that other conditions, besides the total amount of precipitation, enter into the problem.

It is obvious that not all of the precipitation that falls on a drainage area will flow away in the stream. Much of the precipitation will be evaporated and a considerable amount may seep into the ground and flow away through the soil and subsoil, perhaps to some distant point outside of the river basin, or may reappear at some lower level on the same drainage basin and augment the stream flow weeks or months after the rain from which it came has ceased. This condition gives rise to the continuous flow that takes place in streams often during long dry periods during which no precipitation occurs.

The manner of the occurrence of rainfall is important, for if a given rainfall be light, a much greater percentage is evaporated, and a less quantity will flow in the stream. In the same manner a heavy rainfall may give rise to flood conditions and a greater percentage will flow away in the stream, and less be lost in evaporation. The condition of the soil and its porosity are also important. If the soil has been recently saturated it will not take up the quantity of water that will be taken up if no rain has fallen for a considerable period, and hence the greater percentage will be delivered to the stream when one rainstorm rapidly succeeds another. Temperature, also, has a decided influence on evaporation, hence, if the rainfall occurs during high temperature conditions, a greater proportion will be evaporated and lost to the stream. If the precipitation occurs during low temperature it may be held in snow and delivered to the stream when the temperature conditions are again favorable for such results.

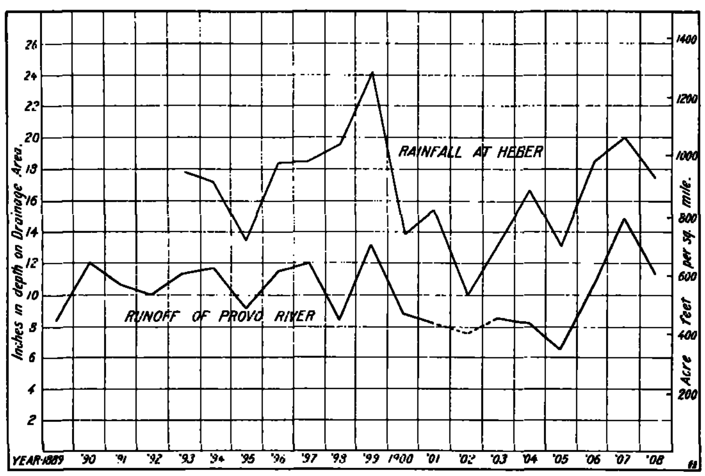

FIG. 1.

The slope of the ground, or the topographical conditions of the drainage area also influence stream flow, for if the slope be abrupt the water will run quickly to the stream, while if the drainage area be level the delivery will be slow and evaporation and seepage will have greater effect.

From these conditions it will be seen that among many important influences which modify and control the flow of a stream are:

1. Quantity of rainfall.
2. Intensity, or manner of occurrence of rainfall.
3. Temperature.
4. Geological conditions.
5. Topographical conditions.

It is usually impossible to gage all these conditions with accuracy, so that conclusions must be more or less approximate on account of imperfect knowledge of the relative weight of each of the controlling conditions.

That stream flow actually varies with rainfall, although not in direct proportion, and that it is always less in amount, is clearly shown in fig. 1, which not only shows the run-off of the Provo River, but also the rainfall or precipitation on its drainage area based on the Weather Bureau records at Heber, which place lies about in the center of the drainage area and is probably fairly representative of the rainfall conditions.

Other things being equal, there is no reason to believe that one square mile of any one drainage area will deliver to a stream any greater quantity of water that a square mile of any other drainage area will deliver to the stream to which it is tributary.

Streams to flow similarly, therefore, must flow under similar conditions. As the rainfall is the primary and most important cause of stream flow, it must be expected that streams otherwise similar will be greatly influenced by the quantity of precipitation.

Having only limited data covering the flow of a certain stream, it will be necessary to determine its probable past and consequent future flow by comparison with other streams more or less similarly situated and controlled by conditions more or less identical.

Graphs of the flow of streams for which long records are obtainable may be compared with those for which there are only limited records. Then, noting the points of similarity or disparity, the long record may be used to complete the short record. This method, while not as satisfactory to an engineer as having the actual data for the stream in question, is used with good results.